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Components of Teacher's Readiness to Manage of Student's Complex Systems and Knowledge Development

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Abstract

Introduction: The student's creativity and self-organization development is determined by the need to process a large amount of information, variability and uncertainty of external factors impact, increasing role of mathematical models in real life. The work of philosophers, psychologists, and teachers shows that the main means of these problems solving can be a process student's complex systems and knowledge mastering. Pedagogical experience, theory and practice, requests and challenges of real life show that the central role in the success of student's mathematics teaching is played by teacher's professional readiness to manage the process of complex systems and knowledge mastering.

The purpose of the study: is to identify the components of teacher's professional readiness to manage and interpret the complex systems and knowledge as factors of student's personality development. The task is to form the teacher's ability to create a rich information and educational environment by changing the content of mathematics teaching in the direction of complex knowledge mastering and supporting a remote environment in the context of mathematical and computer modeling symbiosis.

Materials and methods: It are supposed on the basis of personality-activity, integrative and synergetic approaches, development of diagnostic materials for teachers' professional deficits measuring, to determine the criteria, features, stages, meters, content and structure of teacher's readiness to manage the processes of student's complex systems and knowledge mastering with the possibility of personal experience founding and interpretation of mathematical and computer modeling methods.

The results of the study: It is revealed that the criteria, features, stages, content and structure of teacher's readiness to manage of students complex systems and knowledge development are identified; professional deficits and measures of teacher's readiness to manage of complex systems and knowledge development are determined; approaches, directions and methods of creating a rich information and educational environment for complex systems and knowledge development (including robotic systems, virtual and augmented reality technologies, fractal geometry elements, fuzzy sets and fuzzy logic, etc.) based on mathematical and computer modeling symbiosis have been developed.

Conclusion: The state of personal, subject and methodological competencies and deficits expression should determine the value-motivational, personal-adaptive, cognitive, procedural and generalizing-transformative readiness of the teacher to manage the processes of adapting complex systems and knowledge mastering and ways (modern achievements in science) to current state of students' experience, ability to manage of forms and means representations variability of generalized constructs, proficiency in mathematical and computer modeling methods, samples and standards knowledge of complex knowledge popular applications to real life, technologies and industries.

Keywords: Mathematical education; Complex knowledge; Professional deficits of teachers; Teacher's readines

Introduction

The effectiveness of high technologies implementation in production requires student's developed creative thinking and ability to self-organize and self-develop their scientific potential. Scientists have proved that the development of intellectual thinking operations is possible and effective during the development of complex systems and knowledge [1-4]. Complex knowledge is an information variety of essential connections actualization in the unity of its development and overcoming uncertainties processes in cognitive activity. At the same time, complex mathematical knowledge as a reflection of modern world in the process of its cognition necessarily generates mathematical and computer modeling symbiosis (which is inherent in an essence manifestations of complex knowledge generalized constructs) causes on student's emotional response to applied effects and

integrates knowledge and activities from various fields of science (robotics, artificial intelligence, fractal geometry, fuzzy sets and fuzzy logic, theory of information encoding and encryption, virtual and augmented reality, etc.). This dictates the need to integrate a science and education as a fundamental paradigm for the development of school mathematics education. An essential fact is an actualization of synergetic paradigm in mathematical education [5,6]. Students should already get acquainted with the symbiosis effect of mathematical and computer modeling based on the actualization of nonlinear thinking [7], know and find associations in real life of modern synergetic phenomena in nature, life and technology, such as Benard cells ("the road of giants" in Ireland), Lotka equations - Volterra in the predator-prey system, the Koch snowflake and the Mandelbrot set [8], Ferhulst scenario and the "butterfly effect" of strange Lorentz attractor [9], etc. It is these and similar directions that provide a unique opportunity for motivated involvement of students in the process of subject content coordinated development in rich and open information and educational environment and visual modeling both in the process of formal and informal mathematical education [10]. Therefore, a teacher of modern mathematics should be ready for the level updating and organizing possibility of student's project and research activities based on mathematical and computer modeling symbiosis during complex knowledge development. This need leads to identify the teacher's readiness degree to manage student's complex systems and knowledge development based on the identified criteria and their measures of professional deficits, creating conditions for the multiplicity of goal-setting and selection of mathematics teaching on complex knowledge content, presence of rich information and educational environment in context of mathematical and computer modeling symbiosis, deployment of hierarchical bases and complexes of multi-stage mathematical-informational research tasks, availability of effective feedback and growth monitoring of each student's scientific potential. Therefore, research problem is what are the criteria, features, stages and measures of teacher's readiness determining to manage student's complex systems and knowledge development based on the actualization of value-motivational, cognitive, professional-technological and generalizing-transforming modes of professional activity. Thus, pedagogical support in processes of student's complex systems and knowledge mastering should be carried out by a teacher who has his own experience of complex mathematical knowledge mastering, aimed at student's personal qualities developing, demonstrating the non-standard techniques and methods using for "problem areas" researching of mathematical activity mastering in saturated information and educational environment.

Methodology and Methods

The post-non-classical thinking of modern person based on the nonlinearity of the surrounding reality, situationality and uncertainty in decision-making, multiple goal-setting and ambiguity of strongly choice dictates the need and possibility of complex systems and knowledge mastering as an imperative for the effective development of intellectual thinking operations and science and education integration. Complex knowledge arises in complex systems and generates multiple hierarchies and problems available in mastering the manifestations of mathematical knowledge generalized constructs both at school and at university. Complex knowledge is the knowledge result about semiotic and informational connections content of nonlinear systems, objects and phenomena of real and virtual world, represented in the unity of descriptive and computational diversity and hierarchies of content representation [11]. At the same time, level of perception and personal-activity approach are necessarily realized (L.S. Vygotsky, S.L. Rubinstein, A.N. Leontiev, ets.), based on the individual personification, training activity of student and taking into account the preferences and features of personal development, emotional response actualization to the applied effect of knowledge and competencies being formed (A.Maslow, A.G.Asmolov, N.A. Leontiev, etc.).

One of the fundamental methodological ideas that form the teacher's readiness to manage the processes of student's complex systems and complex mathematical knowledge mastering is the synergetic approach as the basic mechanism of individual self-organization. The synergy of mathematical education in this case will be considered by us as a symbiosis and a qualitative change in nonlinear effects of self-organization and self-development of the individual during the development of mathematical activity in complex stochastic processes management based on the coordination of different factors and principles in three contexts: substantive (semiotic), procedural (imitation) and social adaptation [12]. Positive changes associated with the manifestation of mathematical education synergy generate the deployment of internal mechanisms of student's self-organization during the mathematical construct's development at ever new levels of complexity, while actualizing the ways of forming their mathematical literacy. It is necessary to build the hierarchies of complex multi-level knowledge based on mathematical and computer modeling, self-organization and reliance on didactic rules and patterns of mathematical activity mastering based on synergetic approach and student's personal experience founding. There is a need to develop an environment for distance learning in mathematical disciplines within the framework of developer's methodological initiatives deployment - mathematics teachers, as well as for complexes of on-line courses and remote environments; it is necessary to be able to develop the provision of ICT support tools (including the mathematical package of computer algebra Mathematica, GeoGebra, Lego Mindstorms, Arduino, etc.) in complex systems and tasks development in teaching mathematics; to use the "tetrad" technology in student's research activities: so peculiarity here is that students will have to perform the four types of creative activity (V.S.Sekovanov): a) creative mathematical activity; b) construction of fractal sets with the algorithms and high-level programming languages development; c) performing laboratory work in mathematics

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with computer experiments; d) studying a scientist's creative biographies and creating artistic compositions using fractals and ICT. The mathematical education synergy will be considered by us as a symbiosis and a mechanism of qualitative change in nonlinear effects of individual's self-organization and self-development during the mathematical activity development in complex stochastic processes management based on the coordination of different factors and principles in three contexts: substantive (semiotic), procedural (imitation) and social adaptation [13]. All teacher's professional competencies characterize the manifestation of complex knowledge synergy in mathematical education at school based on modern achievements in science adaptation, mainly in the forms of integrative and elective courses implementation, project activities and web quests, laboratory calculation and resource classes, including in gaming activities.

In the process of students' research of complex knowledge generalized constructs, the influence peculiarities of external factor's actualization are manifested in founding methods and forms of mathematical objects and procedures essence. It based on goal-setting multiplicity, stages and hierarchies construction of sign-symbolic and figurative-geometric activity [14], including a creative search and analysis of side solutions to the problem by using an information technologies and network interactions, variability and parametrization of identification of bifurcation transitions and attraction basins in multi-stage mathematical and informational tasks based on information's ensuring coherence flows during cultures dialogue. The basic tool of personality-activity approach is visual modeling and individualization of students' personal preferences processes in the form of spirals and clusters founding deployment of personality experience - as integral integrating mechanisms for essential connections manifestation of complex knowledge generalized constructs and personality qualities formation. The integrity and orientation of this generalized construct is determined by blocks of meaningful, motivational and applied components deployment based on generic theoretical generalization and technological understanding construction of its specific manifestations. At the same time, it is important to note that the increase in complexity in open and non-equilibrium systems (such is mathematical education) it is not a destructive mechanism, but on the contrary creates the necessary paths and transitions to new level of self-development development. It is noted that the difficulty in achieving of certain critical levels is a synthetic characteristic of self-organizing ability, the ability to develop and self-develop the student's thinking and personal qualities.

Such mechanism and important factor of teacher's readiness to manage a cognitive processes can be the launching of individual's self-organization "factor-impulse" during complex knowledge adaptation development: - by means of updating the content of complex knowledge generalized constructs, including fractal structures as meaningful zones of bifurcation and integrity at increasingly complex levels of mathematical and computer modeling integration. At the same time, the agreed empirical stages (individual manifestations observation and patterns of self-organization activity; identification of facts and their quantitative certainty; identification of structural, statistical, phenomenological laws; theory as an organized set of empirical laws) are deployed [15];- by means of generalized rules and values actualization in visual-digital models of complex knowledge mastering as founding attractors and abilities and processes development of understanding personality);- cultures dialogue and interdisciplinary integration as a means of integrative processes deploying, ways of goal-setting and coherence multiplicity to search for truth, emotional response to applied effects and awareness of information and pedagogical support availability.

An effective construct may be following stages of synergy manifestation deployment of complex knowledge in mathematical education at school as a mechanism for student's mathematical literacy formation: motivational (self-actualization ("I'm interested in this")); approximate information saturation (self-determination ("what can I do")); procedural-activity (self-organization ("I'm capable manage the process")); control and correction (evaluation of results empirical verification); generalizing and transformative (self-development of the personality ("I can do something new")); at the same time, it is necessary to develop the methods for the selection, justification and development of psychological diagnostic methods and evaluation procedures for teacher's professional deficits identifying and technologies for identifying synergetic effects in teaching mathematics.

We note the following features of teacher's readiness to manage of complex problems solution and an implementation of which can actually lead to increase in student's mathematical literacy and creativity in the study of mathematics mastering:- it requires the teacher's ability to design the different descriptions and solutions variety, both in education content and in cognitive processes that differ from each other and complement each other; built, among other things, on the basis of empirical rather than theoretical generalizations, studying of which allows the using of computer and mathematical modeling;- it requires the ability to characterize changes not only at the level of specific manifestations, but also at the level of essence (generalized constructs), most significant for the actualization of understanding processes and developmental effects of self-organization presence. In complex educational systems, effective rules (founding modes of phased deployment) can be distinguished by self-organization types based on visual modeling of content implementation;- requires the ability to explore and adapt the complex dynamic systems (modern achievements in science) to the subject and build of search samples variety (experimental cross–sections, comparative analysis of specific manifestations, computer modeling, analogies, analysis through synthesis, etc.) - real interactions with the system, but not just theoretical activity with its abstract models;- competencies are required in setting diverse, diverse and multi-level goals (multiple goal setting) that can compete with each other. One of the main person's emotional states in complex systems studying

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in mathematical education is uncertainty, doubt, willingness to accept the twofold (based on prediction and random) results of actions, etc.;- it requires the understanding that results of human activity with complex system of mathematical education content and methods, interaction results with it cannot be predicted completely, exhaustively. Only probabilistically guaranteed educational outcomes are possible, therefore, along with direct, predictable educational outcomes, a variety of side, unpredictable products of personal development and mathematical activity are formed, both at school and at university.

The features, criteria, components and characteristics of teacher's readiness to manage of student's innovative activities are covered in sufficient details in pedagogical literature. So, I.B.Beljavskaja [16], N.I.Raitina [17], L.T.Chernova [18], etc., distinguish the following criteria: motivational (cognitive interest in innovation, the need for projects application and implementation, goals formation, self-education and creative self-realization in innovation, receptivity to innovation; the desire for active participation in pedagogical innovations dissemination); cognitive (knowledge of the essence and specifics of innovations, their types and signs; knowledge of the essence of pedagogical design and constructing logic of its stages, the ability to formulate a design problem), operational (the ability to carry out the design and prognostic activities in pedagogical innovation field; possession of situational and supra situated ways of pedagogical situations solving; creating a model of probabilistic professional behavior in conditions of innovative activity; experience in the application of pedagogical innovations in educational practice). A number of scientists N.Plahotniuc, N.N.Savina, E.E.Voropaeva [19] note the importance of such additional criteria as emotional-volitional, personal (the ability to assess adequately oneself as a person, professional, subject of educational process in innovation field, creative abilities), creative (the ability to find the non-standard solutions to pedagogical tasks, the ability to develop the creative imagination and alternative thinking (combine, find analogies, associations) and others. As already noted, the readiness to manage the processes of student's complex systems and knowledge mastering is based and determined on teacher's creative and innovative activity (V.A.Slastenin, L.S. Podymova, etc.) with its own indicators and diagnostic tools. However, the projection of teacher's innovative activity on processes development of student's complex systems and knowledge managing determines its special features of teacher's readiness as in criteria, and in diagnostic tools.

Result

In the course of research and pedagogical analysis of best practices in teacher's determining the readiness for innovation, as well as the problems of student's project and research activities managing, the following criteria and characteristics of teacher's readiness to manage the processes of student's complex systems and knowledge mastering were identified: value-motivational; personality-adaptive; cognitive; procedural; generalizing-transformative (Table 1). The teacher's readiness degree of each criterion severity is determined by teacher's professional deficits volume (personal, methodological, subject and methodological) in the implementation of the processes in development managing by mathematical and informational content of student's complex systems and knowledge. Let's define the diagnostic tools of teacher's professional deficits in accordance with the typology listed above.

Table 1 : Teacher's readiness to manage in processes of complex systems and knowledge mastering.

Criteria	Indicators	Diagnostic tools
Value - motivational	a) presence of external incentives and interests for pedagogical innovations and value acceptance of advanced pedagogical technologies, ideas; b) interest in science and education integration, using of Data Mining tools, tasks, methods and algorithms in effective solution of complex mathematical and information problems; c) personal experience of mathematical and informational creativity and need to develop an individual style of pedagogical activity in student's project management; d) independent ability to tasks and research problems setting, to search for creative methods of problem solving it both for students and for self-realization of teacher; creative level of thinking, striving to overcome stereotypes, harmonization of reflexive outputs, a new creative product, evaluation and prediction of further actions, motivation for self-actualization; e) • experience and culture of psychological diagnostics of student's personal qualities and teacher's self-diagnosis, determination of speed and intensity of cognitive operations, regulation of student's emotional state	a) Map of pedagogical assessment and self-assessment of teacher's abilities to innovate (V.A.Slastenin, L.S.Podymova); b) Questionnaire "Motivational readiness of teaching staff to innovations mastering " (according to T.V. Chirkova); c) Johnson's creativity questionnaire, adapted by E.E.Tunick

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Personal- adaptational	a. wide development of self-diagnosis and development means of teacher's personality motives for self-actualization on the basis of new values acquiring and their own determining the most effective and successful manifestations of pedagogical experience; b. development of convergent and critical thinking; selection of multi-stage mathematical and informational practice-oriented tasks, systematized in the form of founding complexes with necessary stages fixation: problem setting, data collection and analysis, hypotheses, mathematical modeling and analysis of ICT support tools possibilities and their implementation in subject area, reflection and generalization of results; c. ability to pedagogical reflection and development of its types (intellectual, personal, cooperative and communicative), search and analysis of innovative pedagogical problems; d. multiple experiences of micro-problems solving in "warming up" mode and the development of supra-situational activity (emotional experience, reflection, visual modeling, insight, solution verification, transfer); e. competencies in the development of student's divergent thinking against the mastering background of complex knowledge integrative constructs, taking into account the probable and improbable circumstances, constructing the content, stages, basic and variable characteristics of object design; f. ability to adapt and develop in social communications based on self-management principles, role distribution, awareness of personal meanings and preferences, creation of creative groups; formation of a positive "I-position" in the context of cultures dialogue and creative independence; g. pedagogical analysis and ability to transfer of results theoretical and empirical generalizations, reflexive control formation of an individual style characteristics of pedagogical activity; h. intensity of awareness processes of professional motivations, determination of their composition and self-realization; results verification by dissemination and approbation of pedagogical experience	a) Map of pedagogical assessment and self-assessment of teacher's abilities to innovate (V.A.Slastenin, L.S.Podymova); b) Questionnaire "Motivational readiness of teaching staff to innovations mastering " (according to T.V. Chirkova); c) Johnson's creativity questionnaire, adapted by E.E.Tunick

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Creative	a. the presence of samples variability of solving pedagogical problems with analysis and features of complex systems and knowledge creative research (at the reference and situational levels); b. innovative techniques design, for example, "warming up": problem – reflection – visual modeling – insight analysis – verification of solutions – transfer to multifunctional project activities; c. modern technologies mastering for students' research activities managing: founding of personal experience, visual modeling, expansion of metacognitive experience, etc.; d. availability of samples and experience (at the reference and situational levels) of educational and scientific problems solving in mathematical content with detailed information of technology support, analysis and features, presentation of research stages, methods and procedures; e. competence in requirements and types of hypotheses nomination and formulation, analysis of their adequacy, verifiability, reliability; verification of hypotheses, their modification, evaluation of methods and procedures for finding results, varying conditions and data for complex systems and tasks studying; f. management skills in the assessing of hypotheses truth, forecasts and strategies; effectiveness self-analysis of strategies and methods solution, choosing the optimal way to problem solving; g. skills in founding of spirals and clusters designing by type: theoretical and empirical generalization of knowledge and methods, integration of knowledge and methods against the background of obtaining a new quality of interaction, actualization and formation of personal experience in "zones of immediate development"; h. system integration skills of subject, information, mathematical and professional knowledge based on visual modeling in setting and solving tasks of professional activity and development managing of student's research tasks mastering	a) Competence-oriented test of methodological readiness to master of complex systems and knowledge (E.I.Smirnov); b) Evaluation materials of levels measurement in teachers' proficiency in subject competencies in the field of functional (mathematical) literacy in complex systems and knowledge management (E.I.Smirnov)
Procedural	a. technological readiness and culture design: knowledge of methods and means of pedagogical innovation; b. introduction and management of techniques and methods development of scientific cognition, creating situations of intellectual tension, student's self-determination and self-actualization in problematic situations; c. creating of information-rich educational environment (stimulating of success situation; working in small groups; tolerance to uncertainty; readiness for discussions and multiple solutions to problem solving; identification and popularization of creative behavior samples and its results); d. formulation and search managing for research problem solving, information updating and mastering "zones of near and distant associations", forms and methods collecting and a variety of information presenting, probabilistic-statistical, content, graphical, cluster, mathematical analysis of data, identifying patterns, analogies, associations, dynamics of processes, phenomena and facts under studying; e. development management of statistical packages and office editors, small informatization tools, computer algebra systems and Web support; ICT tools capabilities analysis to verify the solution adequacy; f. processes management of designing and building a plan for problem solving, conceptual, subject, information and mathematical models, analysis of ICT support tools capabilities	c) Questionnaire of mathematical modeling competencies in intelligent and robotic systems (N.M. Galaseeva); d) Questionnaire for study of teacher's methodological competence deficits in providing of functional (mathematical) literacy formation in complex systems and knowledge management (E.I.Smirnov)

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Diverse diagnostics in 5 regions on representative samples of teachers (Yaroslavl, Lipetsk, Perm Krai, Nizhny Novgorod, Republic of CO-Alania) of Russia showed that in their innovative activities for management of complex systems and knowledge development (modern achievements in science) the teachers are guided by social motives associated with interaction and creative colleagues, with desire to be in contact with scientists and teachers and an adequately assessed level of pedagogical competencies by scientists. The motives of self-actualization, self-determination and achievements in innovation with the management of student's complex systems and knowledge development do not play a significant role for teachers. This creates an additional problem area for the teacher's readiness processes due to the above-mentioned importance for improving of mathematical education quality and vocational training at the university concerned with actualization of science and education integration during complex systems and knowledge development.

Diagnostics of teacher's methodological readiness to manage of student's complex systems and knowledge development has shown that teacher's professional deficits manifest themselves the most prominently in this niche. Teachers are poorly guided by methodological approaches sound (personal-activity, synergetic, interdisciplinary, etc.) to improve the management quality of students' of complex systems and knowledge development (less than 30% of respondents), insufficiently use the modern methods of forming project and research activities among students (about 45% of respondents), founding of personal experience, visual modeling of mathematical objects and processes (less than 15% of respondents), information technologies and tools are not yet used in mathematics teaching as a necessary tool for mathematical essence mastering of complex knowledge (38% of respondents), teacher's diagnostic culture is at a low level (only 20% of respondents possess methods of mathematical statistics and are able to identify the "problem areas" in student's personal development with valid psychological and pedagogical meters available to the teacher). The availability of subject competencies is the most important problem of teacher's readiness to manage of student's complex systems and knowledge development. The historical experience of world mathematics problems solving shows that, for example, the result of following problems cognition is a complex mathematical knowledge: the problem of 4 colors for coloring maps (V.Haken, K.Appel); Riemann's hypothesis about zeros of zeta function; Goldbach's binary problem; transcendence of numbers π+e; rationality of Euler-Mascheroni number; problem P=NP – difficulties for computational efficiency of iterative problems (P.Cook, L.Levin, A.Wigderson); Fermat's Great Theorem (A.Wiles); fractal characteristics of Schwartz cylinder and Smirnov's "cup" [20]. A generalized construct of complex systems studying (robotic and intelligent systems, cellular automata, machine learning, etc.) and complex mathematical knowledge can represent the applied or practice-oriented knowledge, essence studying and manifestation of which is based on mathematical and computer modeling symbiosis. These can be of fractal geometry elements: variations of Julia and Mandelbrot sets, games of "chaos" in randomized design and studying of fractal characteristics of "Serpinsky napkin" and its generalizations, strange attractors of Henon, Roesler and Lorentz studying; graph theory (transport networks, queuing theory, etc., L.Euler, F.Harari, R.Diesel); fuzzy sets and fuzzy logic (L.Zadeh, Ye Mamdani); information encoding and encryption (K.Shannon, D.Haffman); stochastic methods of optimization problems (J.Holland, J.Koza), etc.

Therefore, teacher's knowledge of modern mathematics, interest in the introduction of complex systems into mathematical training with the actualization of mathematical and computer modeling symbiosis creates a precedent for teacher's readiness to motivated manage of mathematical constructs development, increases of student's mathematical literacy and actualizes the interdisciplinary interaction of academic subjects. However, the results of teacher's diagnostics show a significant professional deficits, extremely insignificant teacher's opportunities and interest in mastering and managing of modern complex systems and knowledge generalized constructs in mathematics teaching (less than 10% of respondents).

This indicates that the majority of teachers (80%) adequately assess their scientific and methodological potential, are tolerant of innovations in didactics, have their own experience in identifying "problem areas" of complex mathematical knowledge mastering (including modern achievements in science). Comparison of time intervals of test execution and low average results of teachers indicates the presence of subject deficits among mathematics teachers in the field of mathematical knowledge applying in practice-oriented tasks solving, as well as in issues of adequate interpretation of task conditions and results.

Therefore, the professional mathematical training of future teacher should not only fund the content of school mathematics at a generalized theoretical level (which is not always observed in curricula and curriculum), but also reflect the content of modern achievements in science adaptation (fractal geometry, fuzzy sets and fuzzy logic, theory of information encoding and encryption, cellular automata, etc.). The approach to school mathematics will create an additional motivational and applied aspect based on mathematical and computer modeling integration.

Methodological competencies of teachers were determined in 6 tasks distributed in 2 blocks: block 1 – factors and problems of complex mathematical knowledge mastering; block 2 - methodological possibilities of categories studying (space and form, change and dependencies, quantity, uncertainty and data) and play activities in mathematical education. The test results are presented in Table 2: The latest results should be regarded as positive – they indicate the teacher's readiness for professional self-development, the ability to adapt and knowledge using of

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science modern problems in practice-oriented tasks solving with student's motivation and self-organization effects, as well as the ability to form a rich information, educational and gaming environment by means of mathematical and computer modeling in practice-oriented tasks solving and of gaming activities organization. At the same time, subject deficits of teachers and factors hindering the processes of complex knowledge adapting to school mathematics were identified: difficulties in conceptual modeling of practice-oriented tasks, understanding of plot situation and its translation into mathematics language; mutual transitions of sign systems in mathematical modeling; difficulties in working with real data, quantities and units of measurement. At the same time, diagnostics showed teacher's difficulties and professional deficiencies in knowledge generalizing and student's activities. It seems as a consequence predicts of teacher's insufficient ability to bring the student on the level of private knowledge generalization, actualize the meta-subject competencies and universal educational actions: without such an analysis and proper emphasis, student's knowledge and actions will be limited and will have a weak potential for expansion. One of the ways to solve this problem is to study and adapt a modern achievement in science to school mathematics (robotic and intelligent systems, fractal geometry, the theory of encoding and encryption of information, fuzzy sets and fuzzy logic, etc.).

Table 2 : Test Results.

Block/Results	Average (score / max)	%
1	86/134	64,2
2	81/134	60,4
∑	83,5/134	62,3

Discussion

We agree with the authors [21-23] about the need to solve complex problems in mathematics teaching by integrating mathematical and computer modeling (GeoGebra, Maple, Deep Learning, STEM-education). In particular, with the effect of student's mathematical literacy formation [24,25] on the basis of practice-oriented tasks comprehensive solution in various directions (nature, society, infrastructure, science, production). However, scientists have proved that the teacher's readiness to manage of complex systems and knowledge development requires not only efforts in the operationality of innovative activities with complex systems, but also an internal organization of student's symbolic activity with high level of educational motivation and interdisciplinarity in modeling practice-oriented tasks actualization is necessary [26,27], which is confirmed by our research. The data obtained by us are consistent with the opinion of next authors [28-30] about weak readiness of teachers to innovate modern achievements in science using (fractal geometry, fuzzy sets and fuzzy logic, machine learning, etc.). Therefore, original direction of improving the mathematical education quality is technology's introduction and transfer for complex knowledge studying based on the determining of teacher's readiness to manage of student's cognitive activity on the development of complex knowledge generalized constructs.

Conclusion

It is revealed that the central role in success of various levels determining of teachers' readiness to manage of student's complex systems and knowledge development is played the teacher's tolerance for self-education, development of their fundamental mathematical competencies, understanding the significance of overcoming difficulties in student's abilities and intelligence development. An essential factor in complex systems and knowledge development is problem solving in creating of rich information and educational environment for mathematics teaching by changing the content of educational programs and practices in direction of complex knowledge mastering. This should be realized in the course of step-by-step studying of complex knowledge generalized constructs and complexes of practice-oriented subtasks solving. It leads to ability in effectively interpreting tasks from real life: that is, to solve a wide range of tasks in various spheres of human activity, communication and social relations. The priority for teacher's readiness is situations when student's ability to use the existing knowledge and skills, to obtain a new information is manifested. The creative students who think independently and able to function in difficult conditions and master of complex knowledge are required. This creates a precedent for teacher's readiness to innovate with complex systems and knowledge, to expand and deepen the student's experience based on his current status (it is necessary to take into account the individual differences of students, i.e., practice-oriented tasks should be multi-level). Formation and development of motivational sphere of teaching (due to samples and adaptation of modern scientific knowledge and technologies actualization that are in demand in life and accessible to perception), development of intellectual operations and abilities are based on founding mechanisms, mathematical and visual modeling of manifestation possibilities and correction of student's functional, operational and instrumental competencies in mathematics complex constructs and procedures mastering. The conducted research revealed an integral block of teacher's personal, methodological, subject and methodological deficits in complex systems and knowledge mastering and adapting to

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school mathematics and processes managing of student's self-organization in research activities.

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